

CLAIMS

1 1. A system for scanning a target of interest comprising:
2 a high-resolution collecting optic;
3 a spatial modulation reticle located in a high-resolution image plane of the col-
4 lecting optic, the reticle being movable in the image plane;
5 a demagnifying relay optic;
6 a primary small-format focal plane array (FPA) detector located in the demagni-
7 fied image plane that receives reticle-modified images and outputs image frames; and
8 a processor that performs, with the image frames, balanced demodulation function
9 that reduces image clutter where the target of interest is in motion.

1 2. The system as set forth in claim 1 wherein the balanced demodulation function
2 comprises:

$$VV = \sqrt{\left(V_2 - \frac{V_1 + V_3}{2}\right)^2 + \left(V_3 - \frac{V_2 + V_4}{2}\right)^2 + \left(V_6 - \frac{V_5 + V_7}{2}\right)^2 + \left(V_7 - \frac{V_6 + V_8}{2}\right)^2}$$

5 6 in which

7 V_r is an output image frame from the FPA on frame number r , and
8 VV is a demodulated output frame derived from a sequence of 8 image frames.

1 3. The system as set forth in claim 2 wherein the demodulation function is defined
2 by a predetermined frame delay and wherein a choice of the predetermined frame delay is
3 made according to a known or expected scene motion environment and a known angular
4 subtense of each of a plurality of cells of the reticle so as to maximize a degree of clutter
5 reduction.

1 4. The system as set forth in claim 1 wherein the processor is adapted to perform
2 enhanced detection of the target-of-interest in motion, wherein a derived motion of the

3 target-of-interest based upon a detection scenario is used to adjust a motion of the reticle
4 so as to generate a desired result.

1 5. The system as set forth in claim 4 wherein the motion is derived by monitoring
2 pitch and roll rates of a movable support that carries each of the high-resolution collect-
3 ing optic, the spatial modulation reticle, the demagnifying relay optic and the FPA de-
4 tector.

1 6. The system as set forth in claim 1 wherein the reticle includes a plurality alter-
2 nating transmissive and non-transmissive cells and wherein a size of each of the cells is
3 defined by a desired instantaneous field-of-view (IFOV) and matches an achievable point
4 spread function (PSF) of the high-resolution collection optic.

1 7. The system as set forth in claim 6 wherein the a cell-to-cell variation in area for
2 each of the cells with respect to all other of the cells is less than 1% and wherein each of
3 the non-transmissive cells are 100% opaque in a spectral band of interest and wherein a
4 transmissivity of each of the transmissive cells varies by no greater than 1 % with respect
5 to the transmissivity of all other of the transmissive cells.

1 8. A system for spatial modulation of light in a sensor array that scans an image of
2 a scene comprising:

3 a reticle with fixed cell pattern of opaque and transparent cells, created by depo-
4 sition, etching and photolithography processes, and having a long stroke drive mecha-
5 nism to translate the reticle across a full extent of the image of the scene at constant ve-
6 locity.

1 9. A system for spatial modulation of light in a sensor array that scans an image of
2 a scene comprising:

3 a reticle with fixed cell pattern of opaque and transparent cells, created by depo-
4 sition, etching and photolithography processes, and having a short stroke oscillatory drive
5 mechanism to translate the reticle at least four cell widths at constant velocity plus turn-
6 around-and-velocity-stabilization time at each end of the stroke.

- 1 10. A system for spatial modulation of light in a sensor array that scans an image of
2 a scene comprising:
 - 3 a reticle with fixed cell pattern of opaque and transparent cells; and
 - 4 an active digital device that provides independent control of each of the cells,
 - 5 the digital device including at least one of micromirror arrays, addressable membrane
 - 6 mirrors and pneumatic liquid crystals.
- 1 11. In a sensor array that scans an image of a scene having a reticle composed of a
2 matrix of transmissive and non-transmissive alternating cells arranged so that the matrix
3 measures SMF cells by SMF cells with each of the cells being a predetermined cell
4 width, a back end relay optic that directs light to a detector from the reticle comprising:
 - 5 a lateral demagnification in the back end optic equal to a ratio of SMF x reticle
 - 6 cell width to a detector pixel pitch.
- 1 12. An apparatus for spatial modulation imaging (SMI) including a high-resolution
2 collecting optic, a spatial modulation reticle located in a high-resolution image plane of
3 the collecting optic, the reticle moving in the image plane, a demagnifying relay optic and
4 a primary small-format focal plane array (FPA) detector located in the demagnified im-
5 age plane, the apparatus further comprising:
 - 6 a foveal enhanced imaging (FEI) mechanism having an amplitude beamsplitter
 - 7 located either (a) just before or (b) after the reticle moving plane, to split off a fraction of
 - 8 a high-resolution image intensity; and
 - 9 a spectral band width or polarization component, for retaining the high-
 - 10 resolution image by routing it to one of either a secondary focal plane array detector or a
 - 11 shared portion of the primary FPA.
- 1 13. The apparatus as set forth in claim 12 further comprising an additional small-
2 format FPA employed to output the high-resolution image of a selected subarea from the
3 scene, an extent of the subarea being determined by a size of the additional FPA.

1 14. The apparatus as set forth in claim 13 further comprising a secondary optical
2 path that leads from the beamsplitter through a 1:1 magnification optic to the additional
3 FPA.

1 15. The apparatus as set forth in claim 14 wherein the additional FPA is located di-
2 rectly on the reticle surface to intercept the high-resolution image and is adapted to be
3 slewed to the desired point in a scene of the high-resolution image.

1 16. An apparatus for spatial modulation imaging (SMI) including a high-resolution
2 collecting optic, a spatial modulation reticle located in a high-resolution image plane of
3 the collecting optic, the reticle moving in the image plane, a demagnifying relay optic and
4 a primary small-format focal plane array (FPA) detector located in the demagnified im-
5 age plane, the apparatus further comprising:

6 a foveal enhanced imaging (FEI) mechanism having an amplitude beamsplitter
7 located either (a) just before or (b) after the reticle moving plane, to split off a fraction of
8 a high-resolution image intensity; and
9 a spectral bandwidth or polarization component, for retaining the high-
10 resolution image by routing it to a shared portion of the primary FPA.

1 17. The apparatus as set forth in claim 16 further comprising a secondary optical
2 path that leads from the beamsplitter through a 1:1 magnification optic to the shared por-
3 tion of the primary FPA.

1 18. A system for foveal enhanced imaging of a scanned scene in a sensor having a
2 large throughput collection optic and a high-resolution scene image at a reticle plane and
3 a lower-throughput relay optic and low-resolution scene image that follows at a detector,
4 the system comprising:

5 a mechanism that employs spillover light that is otherwise lost in a transition
6 from the large throughput collection optic and high resolution scene image at the reticle
7 plane to the lower throughput relay optic and low resolution scene image that follows at
8 the detector plane.

1 19. The system as set forth in claim 18 wherein the mechanism includes one of ei-
2 ther a large-diameter folding mirror with a hole in center for capturing the spillover light,
3 or a dichroic beamsplitter with an appropriately transmitting center area, so as to pass the
4 light passing through an acceptance aperture the relay optic while reflecting to the side all
5 the light that falls outside the acceptance aperture of the relay optic, and a slewable relay
6 mirror that refocuses the otherwise-lost light onto a second FPA to display a foveal en-
7 hanced image of a selected subarea of the scene.